Wettest October on record for eastern Scotland

Description

Eastern Scotland had its wettest October on record in a series which goes back to 1836, with some counties seeing well over twice their average rainfall for the month, according to provisional Met Office figures.

Eastern Scotland broke its record for rainfall in October, with 235.9mm of rain being 82% more than its average. There were significant and very severe flood impacts in the area during Storm Babet, with two red rain warnings issued by the Met Office.

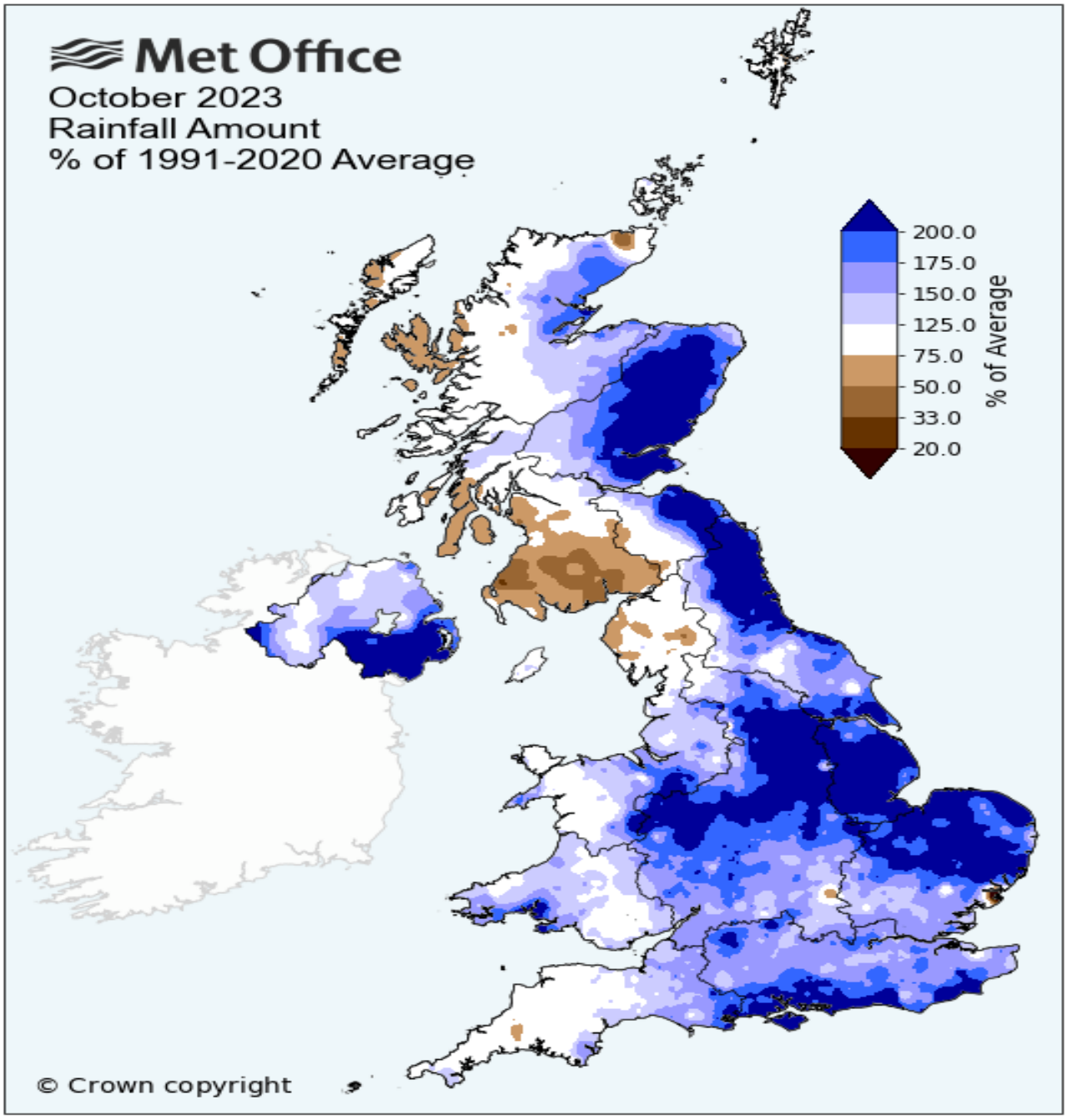
In more granular detail, Angus, Dundee, Fife and Kincardineshire were among a number of counties that recorded their wettest October on record as Storm Babet followed early month exceptional rainfall in a sodden period for many.

A month of rain

The UK had over a third more rain than average with 171.5mm (40% more than average) in what was provisionally the joint-sixth wettest October on record.

Northern Ireland had its fifth wettest October on record with 191.8mm being 68% more than its average. England had its eighth wettest on record with 147.2mm of rain, which is 63% more than average.

In addition to some counties in the east of Scotland; Staffordshire, Nottinghamshire and the Isle of Wight also provisionally had their respective wettest October on record. In Northern Ireland, counties Armagh and Down also had their wettest October.



The start of the month saw a marked north-south contrast in weather across the UK. Scotland bore the brunt of rainfall from Atlantic fronts, with 6 to 7 October the wettest 2-day period on record for Scotland in a series from 1891. Further south, England and Wales saw a significant warm, dry and sunny spell with temperatures widely in the low 20s °C and 25°C on four consecutive days in the south-east.

Since then however, rainfall has never been too far away from the UK, with figures increasing dramatically from Storm Babet's influence on 18 to 21 October.

Babet's impacts on England and Wales were chiefly felt from 18 to 20 October, in what was the third-wettest 3-day period for England and Wales in a series from 1891, while the Midlands provisionally

recorded its wettest 3-day period on record. Eastern Scotland also saw exceptional rainfall as part of the event, with 200mm of rain falling in some of the wettest areas.

Met Office Senior Scientist Michael Kendon said: “Despite some warmth in the south early on, October 2023 overall goes down as a wet month for much of the UK, with some areas seeing record-breaking levels of rainfall.

“From mid-month, a blocking high set up over Scandinavia has tended to prevent low pressure systems from clearing the UK to the east. Associated with this, the frequent unusual south-easterly flow in eastern Scotland has particularly contributed to the wet month in this area – normally one of the driest parts of the UK.

“Interestingly, areas to the west, where you’d typically see more rain at this time of year, have been sheltered by the mountains from the worst of the weather, with generally below average rainfall during the month. This has helped prevent national figures from threatening any records.”

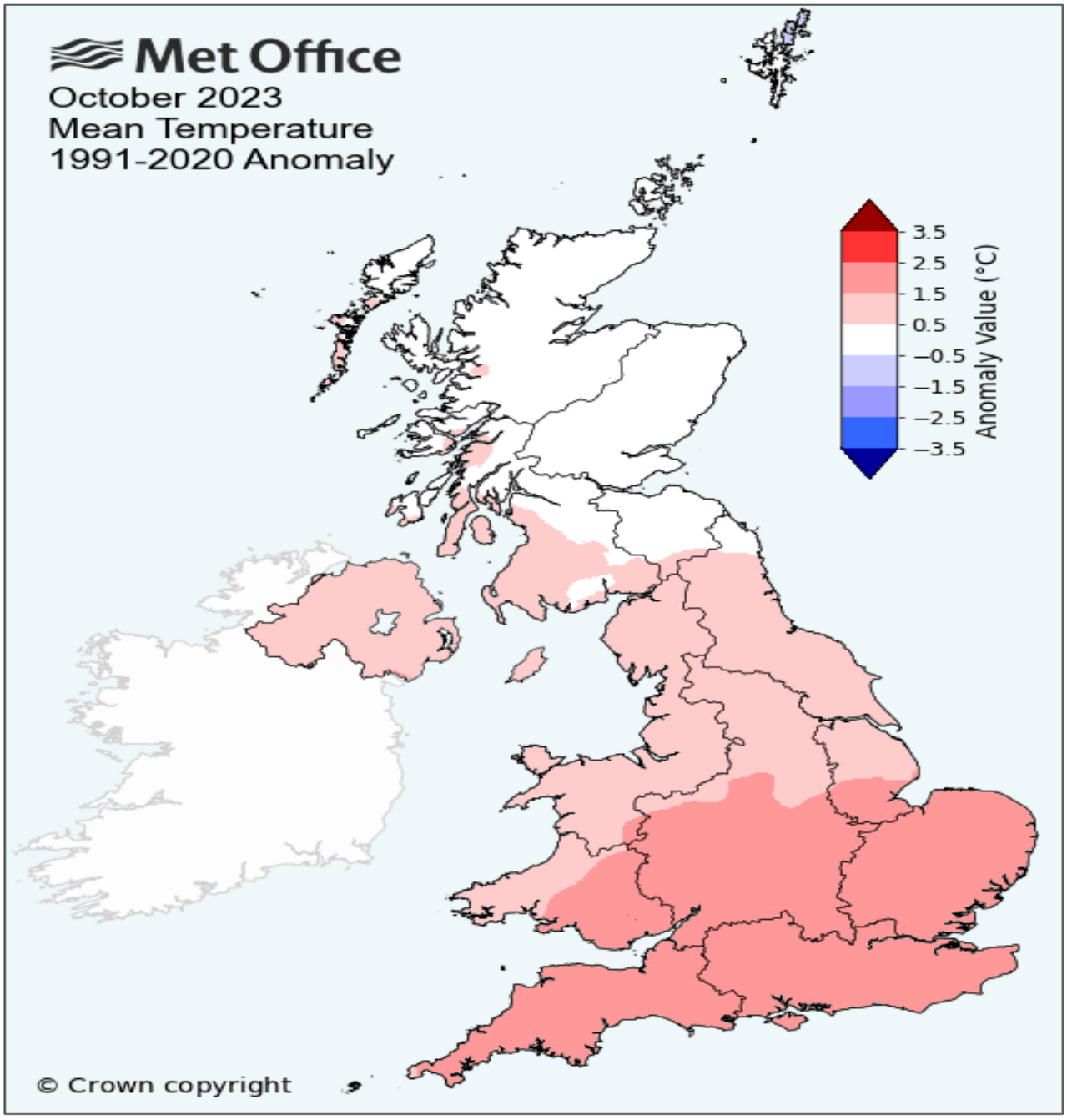
Rainfall and climate change

As the atmosphere warms due to human induced climate change it can hold more moisture, at a rate of around 7% more moisture for every degree of warming. On a simple level, this explains why in many regions of the world projections show an increase in precipitation as a consequence of human induced climate change.

The UK’s observations show large variability in annual, seasonal, and decadal rainfall. However, overall they also show that not only is our climate getting warmer, it is also getting wetter, consistent with this expected increase. In particular, several different measures show a slight increase in heavy rainfall in recent decades.

In the future, climate projections for the UK indicate that in October, November and December, areas of the UK will likely see more days with rainfall totals over 50mm, but particularly in the west.

Mild month for some

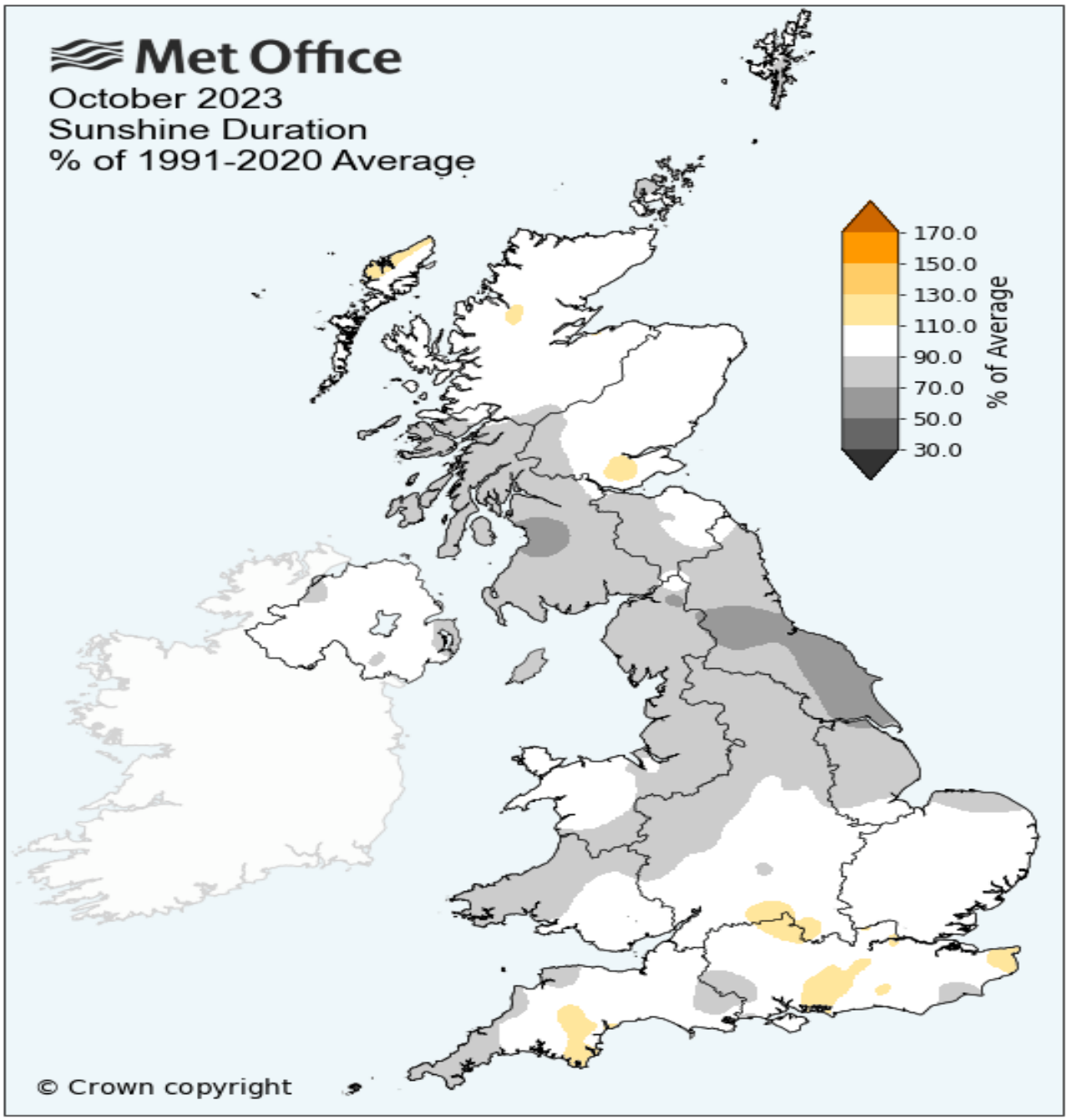


Despite the wet weather, temperatures have generally remained above average for the month, with southern England the warmest compared to average – typically between 1.5 and 2°C above the 1991-2020 October long term average.

For most counties in the south of England, the October mean temperature was within their respective top ten for the month, though none reached any record levels.

The UK’s mean temperature of 10.8°C in October 2023 is 1°C above average, though areas further north were generally closer to average. Scotland’s mean temperature of 8.3°C was 0.2°C above average.

Sun in short supply



As expected with frequent and heavy rain, it was a rather dull month, particularly across central parts of the UK, with below average hours of sunshine for many.

The UK had an average of 84.8 hours of sunshine in the month, which is 8% less than the long-term average. Northern England had a particularly dreary month, with 73 hours of sunshine being 22% fewer than its average for the month.

Provisional statistics	**Rainfall mm / %**		**Sunshine hours / %**	
October 2023	**Actual**	**1991/2020 Anomaly**	**Actual**	**1991/2020 Anomaly**
UK	171.5	140	84.8	92
England	147.2	163	94.8	92
Wales	208.6	132	82.8	90
Scotland	198.7	118	69.4	93
Northern Ireland	191.8	168	80.1	94

Provisional rainfall and sunshine statistics for October 2023

Provisional statistics	**Maximum temp °C**		**Minimum temp °C**		**Mean temp °C**	
October 2023	**Actual**	**1991/2020 Anomaly**	**Actual**	**1991/2020 Anomaly**	**Actual**	**1991/2020 Anomaly**
UK	14.0	0.9	7.6	1.1	10.8	1.0
England	15.6	1.5	8.6	1.5	12.1	1.5
Wales	14.5	1.2	8.5	1.6	11.5	1.4
Scotland	11.1	-0.2	5.6	0.4	8.3	0.2
Northern Ireland	13.9	1.0	7.9	1.5	10.9	1.3

Provisional temperature statistics for October 2023

Season so far

With two months of meteorological Autumn down, the season so far has been warmer than average, particularly in the south, while many parts in the east of Scotland, England and Northern Ireland have already had more than their average rainfall for the whole season – and a few spots as much as 150% – with a month still to go.

At this point in the season, you'd expect places to have had around 67% of their average rainfall for the whole season.

With a month of the season still to go, there's plenty of chance for the figures to adjust before the conclusion of meteorological autumn. Storm Ciaran and the generally unsettled outlook are likely to see the autumn rainfall figures continue to increase substantially.

Date Created
November 2023

2023: on track to be Earth’s warmest year on record

Description

Every month of 2023 has so far has exceeded 1.2°C above pre-industrial times [note], according to the HadCRUT dataset.

These high values are influenced by the ever-rising temperatures driven by human-induced climate change, as well as the influence of the developing El Niño – a cycle of natural climate variation in the tropical Pacific which imparts warmth from the ocean to the atmosphere which temporarily raises global temperature.

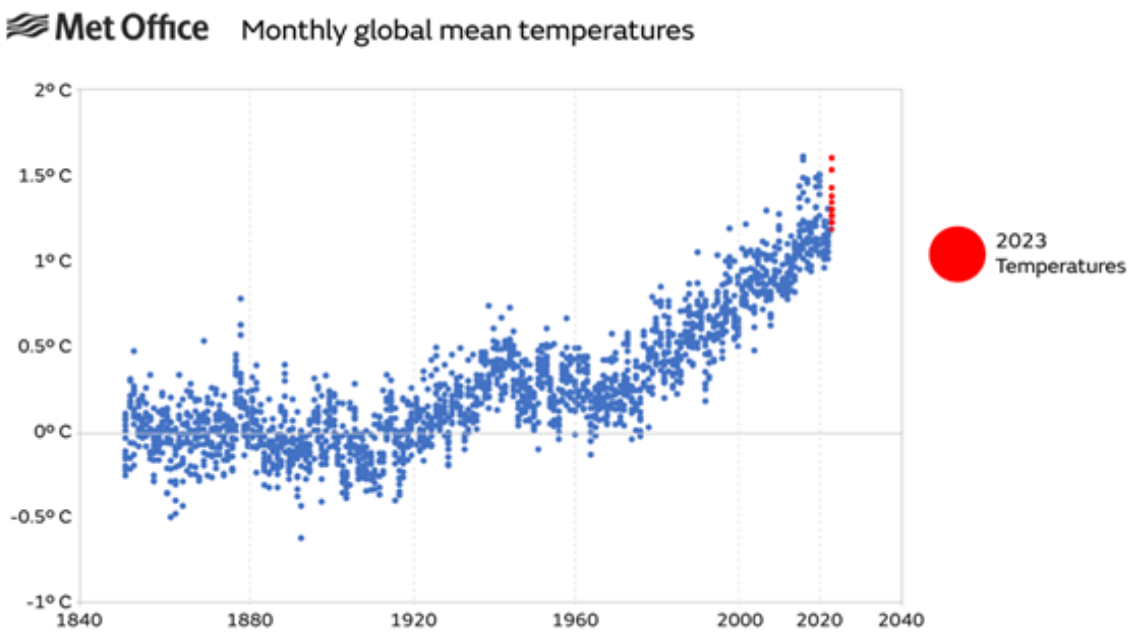
If the relatively high monthly temperatures recorded this year continue, the year is on track to exceed the annual temperature of 2016 – which is currently the warmest year in the HadCRUT series.

HadCRUT5 provides a series of global annual and monthly temperature values from January 1850. In the series the first time a monthly value of 1.2°C exceeded was February 1998 – also another El Niño year.

The record month in the series is February 2016, very marginally ahead of September 2023.

What does all of this mean for global temperature trends?

Colin Morice is a Met Office Climate Monitoring and Research Scientist.He said: “Human influence continues to be the dominant driver of increasing global temperatures. “2023 has been further influenced by the onset of El Niño in the tropical Pacific and has seen notably warm temperatures over land and sea. 2023 is on track to be the warmest year on record if the current conditions continue to the end of the year.”



The above graph shows the difference from the 1850-1900 (°C) average for each calendar month. 2023 months (January to September) are shown in red.

March 1990 was the first calendar month to exceed 1.0°C in the HadCRUT5 series. The last month to be below the long-term 1850 to 1900 average was October 1976.

The coldest calendar month in the series was January 1893 when temperatures were -0.62°C below average.

[Note]: The global temperature for pre-industrial times is taken as an average of the period between 1850-1900.

Date Created
November 2023

CSSP China: Celebrating a decade of scientific collaboration

Description

A project aimed at enabling the development of cutting-edge climate science and its pull through into decision making and on-the-ground services is marking its 10th anniversary.

Launched in 2014, the Climate Science for Service Partnership (CSSP) China is a vibrant collaborative climate science and services initiative between research institutes in the UK, including the Met Office and China.

The project has delivered world-leading climate science research for services to support climate resilient economic development and social welfare around the world. The impact and reach of this research is wide and contributes to ongoing scientific projects globally and in the UK. CSSP China has also attracted interest beyond academia, with media coverage highlighting the significance of the work more than 900 times, and policymakers worldwide citing scientific reports created from the project in more than 100 policy documents.

It has stimulated strong scientific partnerships, harnessing the expertise of the Met Office, the China Meteorological Administration (CMA), the Institute of Atmospheric Physics (IAP) at the Chinese Academy of Sciences, and other key institutes in China and the UK. The project has recently celebrated its 10-year anniversary at its Annual Science Workshop held at the Met Office in Exeter, with delegations attending from all partners as well as wider stakeholders.

The workshop provided an opportunity to evaluate the scientific advances made by the project and to identify prospects for further innovation. Discussions identified research opportunities and cross-project activities that will strengthen Met Office-China collaborations in climate science and services, on topics such as extreme weather events, food security and plant health, and major El Niños and their impacts, which will help deliver increased climate resilience around the world. A special anniversary cake was also prepared to mark the occasion and celebrate the project successes and future opportunities.

Sean Milton, CSSP China UK Project Executive from the Met Office, commented: “It was wonderful to reconnect face-to-face again following 3 years of virtual workshops to hear about research opportunities and facilitate sharing of knowledge and expertise. I was particularly impressed by early career researchers who gave presentations. We are very excited by what CSSP China could achieve in the coming years and very much looking forward to its continued success.”

Qingchen Chao, Deputy Director-General for the National Climate Center, China Meteorological Administration recently commented in a new video for the project: “The CSSP China programme has lasted 10 years and is recognised as the most fruitful China-UK meteorological cooperation project for the longest duration and the largest participation. I have witnessed that the project outputs have supported national policy making and benefitted social and economic development. I believe the new decade will witness strengthening partnerships of climate communities between the UK and China, upon the solid foundation laid by the CSSP China programme.”

CSSP China conducts climate science research spanning observational studies, predictions of weather and climate extremes and the development of climate models and climate services for decision

making. It has created a firm legacy in these areas and facilitated the pull through of science into services that are supporting decision making globally. An important legacy of the partnership is the exceptional body of peer reviewed science it has produced, with over 500 studies published in the scientific peer reviewed literature which have attracted more than 10k citations by other global academics.

To help further showcase these within the research community, CSSP China has published a special issue in the scientific Journal Advances in Atmospheric Science (AAS), highlighting the internationally collaborative research from the project with 13 papers on key research topics. The issue showcases the breadth of CSSP China, with research papers ranging from studying the predictability of the Asian summer monsoon to observational work on the records of extreme humidity. The issue documents how the project is further developing seasonal climate services by extending the lead time for predictions of Yangtze river basin summer rainfall to over six months in response to user needs.

Adam Scaife, who was the UK science lead on the project until earlier this year, said: “This latest set of science papers adds new climate science highlights to the already enormous contribution made by our collaboration, and this becomes all the more important as we experience unprecedented levels of global change.”

Looking ahead, the project teams are fully committed to developing innovations and world-leading science that will help meet the challenges of the next 10 years – ‘the critical decade’ for tackling climate change and building resilience to the impacts of weather and climate extremes. The CSSP China project is part of our Weather and Climate Science for Service Partnership (WCSSP) programme, supported by the UK government’s Department for Science, Innovation & Technology (DSIT). Explore more research insights and impacts via the WCSSP Impact Brochure and CSSP China video showcasing specific successes to date.

Date Created
November 2023

UK Greenhouse Gas Emission Verification System

Description

This month we are exploring the topic of emissions trends and drivers. Here we take a look at how national emissions are estimated and the relevance of this information for policymakers.

Developed countries have an obligation under the United Nations Framework Convention on Climate Change (UNFCCC) to provide detailed annual summaries of their emissions of the principal greenhouse gases (GHGs): carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

This official reporting process uses a bottom-up approach based on counting different emission activities (e.g., cars, trains, cows, landfill sites, industrial process etc.), multiplying them by the emissions per activity (e.g., number of cows multiplied by emissions per cow) and summing these numbers per gas to arrive at a country total. There are hundreds of different activities defined, each with their own emission factor per gas.

An approach using atmospheric observations ('top-down')

An alternative and complementary approach to estimate GHG emissions is the so called top-down method. This uses precise, high frequency, atmospheric measurements of the concentrations of each GHG combined with a computer model to represent the transport of the gas from source to measurement point.

This method is commonly referred to as inverse modelling. These top-down estimates require complex atmospheric transport models using high quality meteorological data, combined with the atmospheric measurements and inverse models. This alternative method can be used to complement and help improve the reported bottom-up inventory.

The UK was the first country, in 2003, to independently compare their bottom-up emissions data reported to the UNFCCC with top-down methods. Currently very few countries (the UK, Switzerland, Australia and the USA) have this capability, however, as we seek to reduce GHG emissions and reach Net Zero, it will be important for nations to be able to verify their reporting, and for the international community to have confidence in the reporting of emissions from all nations.

The UK GHG observations network

The UK GHG observation network is shown in Figure 1 below, along with the Mace Head site in Ireland. This network is currently being expanded with a new site in Scotland and one in north-west England. Most of the sites are based at tall-tower (90m – 250m) telecommunications stations which allows them to sample well-mixed air from a wide area.

This network is referred to as the UK DECC (Deriving Emissions related to Climate Change) network and is discussed in detail in the paper Stanley et al. 2018. It is funded, along with the top-down

modelling, by the UK government through the Department for Energy Security and Net Zero. The top-down estimates also make use of the GHG observations from across the European continent.

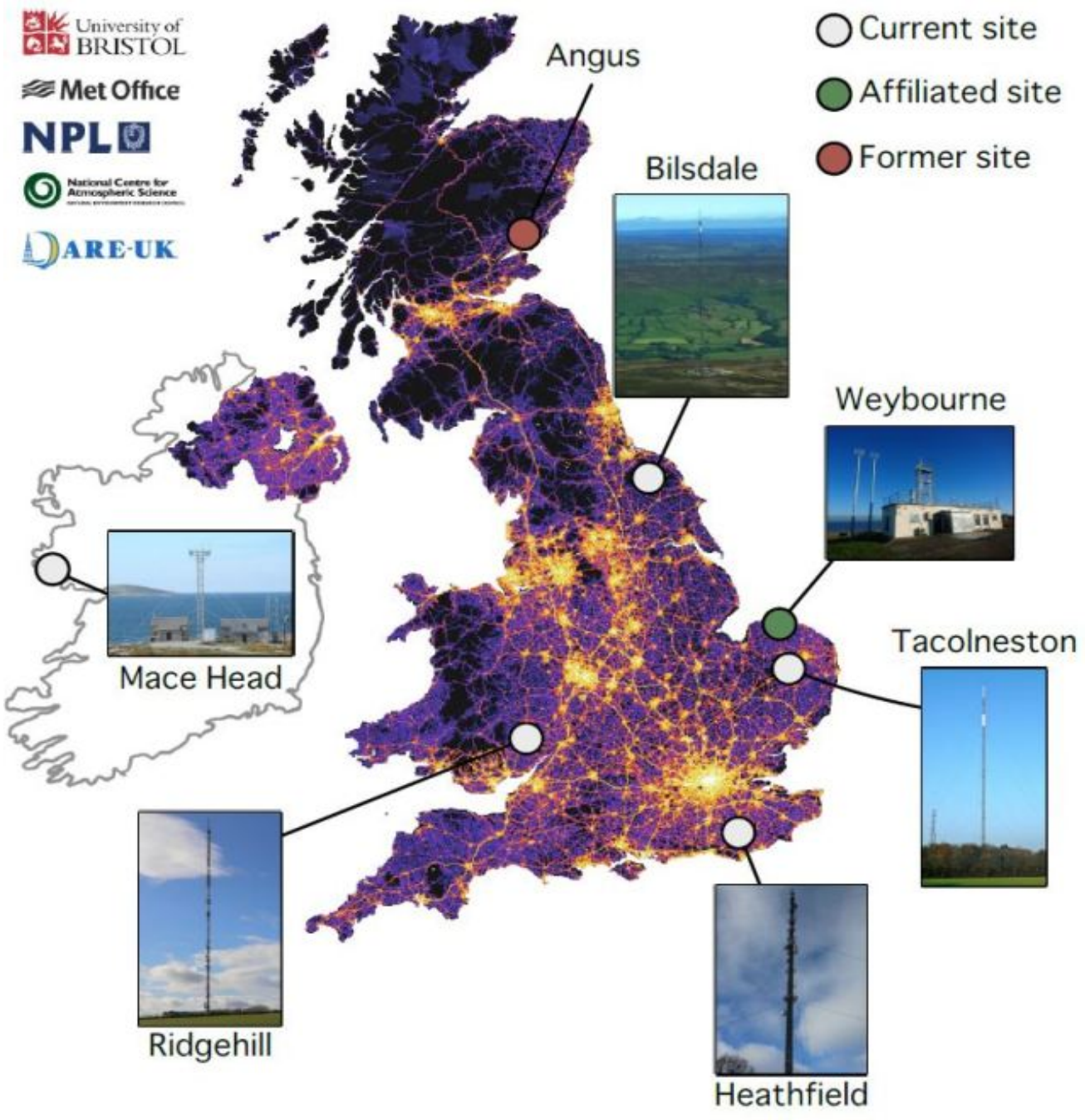


Figure 1: UK GHG tower observation network. The UK map shows the reported CO_2 emissions from one year as an example. Brighter colours indicates larger emissions.

Model development

The top-down method used in UK reporting is called an Inversion Technique for Emission Modelling (InTEM) and has been developed over the last two decades by the Met Office (model details can be found in the paper Manning et al. 2021). The model essentially tries to find a geographical distribution

of emissions, for each different gas, that allows it to best reproduce the observations for that gas, recorded at the different measurement stations. These emissions are then summed up across the country and compared to the bottom-up inventory.

An example of this is shown in Figure 2 for UK methane below, with the bottom-up inventory shown as black bars, and the top-down InTEM estimate shown as a blue line.

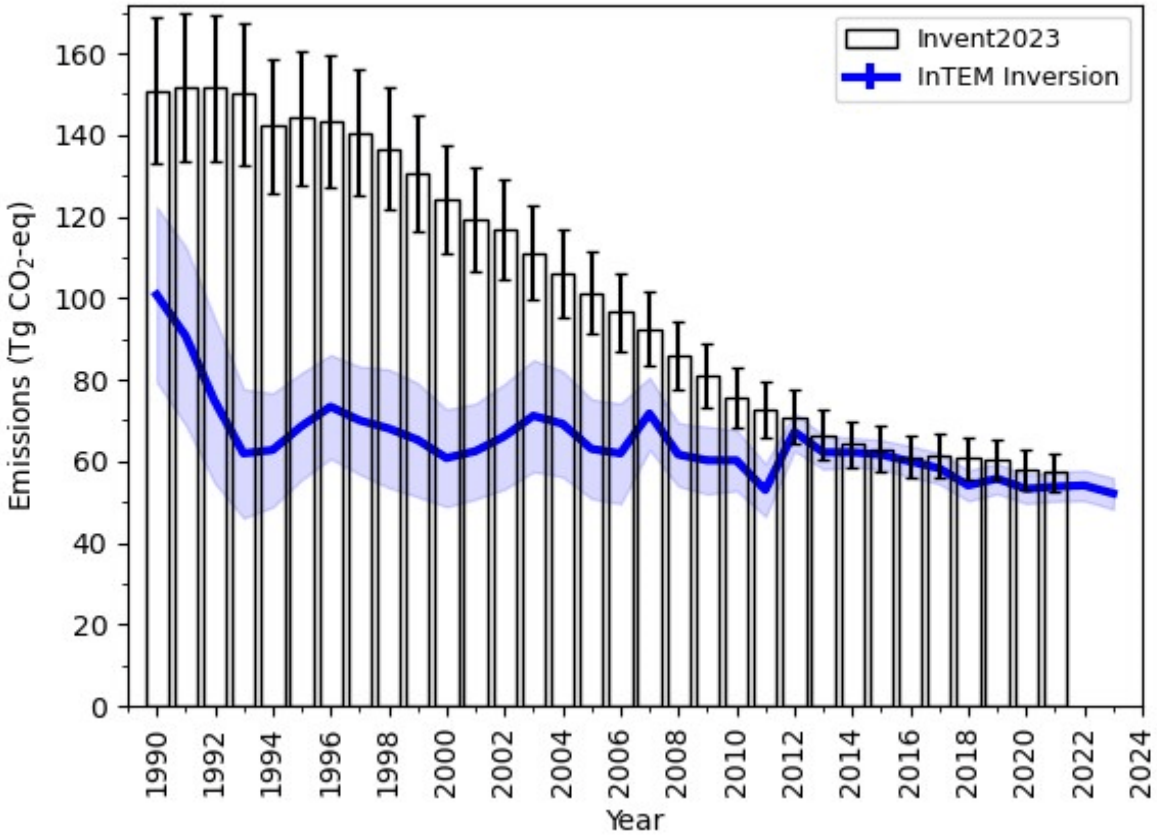


Figure 2: UK emissions of methane (CH_4) in Tg CO_2-equivalent from 1990 as reported to the UNFCCC in 2023 (bars) and the estimates from InTEM (blue line), an atmospheric observation derived estimate. Uncertainties are to 1-sigma.

Alistair Manning, Scientific Manager at the Met Office, explains, “There is very good agreement between the bottom-up and top-down estimates from 2012 onwards, both showing a slowly declining trend, however there are significant disagreements in the 1990s and 2000s. This mismatch is currently under investigation and could be caused by a range of factors in both the top-down and bottom-up methods, which have both been developed significantly in more recent years. Such disagreements are used by the inventory community to help direct their efforts to continually improving the reported inventory values.”

As part of the top-down modelling process, the northern hemisphere and southern background concentrations of each gas are estimated, as shown for methane in Figure 3 below. This example highlights the increasing concentration of methane in both hemispheres and also reveals that the majority of the emissions are in the northern hemisphere, as shown by the lower southern hemisphere

concentration, driven by the slow mixing between the hemispheres.

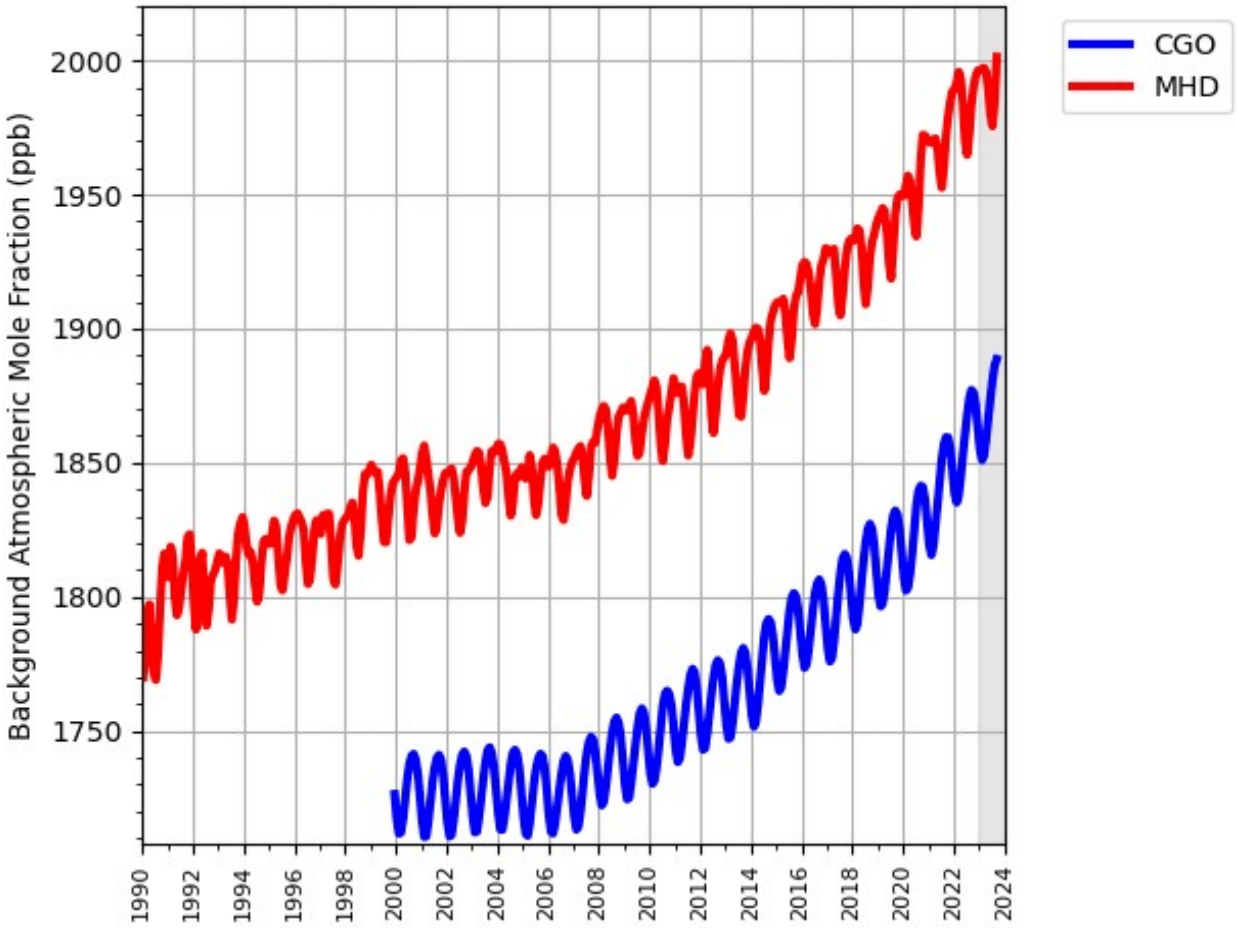


Figure 3: Well-mixed northern (red) and southern (blue) hemisphere concentrations of methane measured at a remote site on the west coast of Ireland (MHD) and north-west Tasmania, Australia (CGO).

Value to policymakers

Understanding the impact and effectiveness of policies on the atmospheric abundance of GHGs is vitally important to policymakers to demonstrate the effectiveness of their policies. This type of top-down independent emissions verification is considered good practice by the Intergovernmental Panel on Climate Change (IPCC, 2019) as it assists inventory compilers by identifying inconsistencies between the two approaches, thereby having the potential to improve the accuracy and reduce the uncertainty in nationally reported inventories.

A benefit of the top-down method is that the estimates are available faster (3-6 months behind real-time) than the bottom-up estimates, which take up to two years to publish. There remain considerable scientific challenges in this field of research, a key one being that carbon dioxide, the most significant GHG, is very difficult for top-down methods to model due to the significant complications of the natural biosphere. This remains a key research challenge.

Date Created
November 2023

Why an ‘exact date’ weather forecast headline isn’t what it seems

Description

As we move further towards meteorological winter, one thing as predictable as the changing seasons is online news headlines that promise the ‘exact date’ we will see snow in the UK, often weeks in advance. But where do these dates come from and how do you know if they are accurate?

Forecasting uncertainty

Despite the certainty suggested in some online headlines, meteorology isn’t an exact science, and although forecast accuracy is improving (the Met Office’s 4-day forecast is as accurate as its 1-day forecast was 30 years ago), long range predictions come with in-built uncertainty. It’s this uncertainty that isn’t always captured by some online headlines.

Met Office Senior Presenter and Meteorologist Alex Deakin said: “The weather by its very nature is chaotic. Small differences in conditions can have a significant impact on the forecast in the following days and weeks.

“It’s these small discrepancies which mean it’s nearly impossible to talk with absolute certainty about the specific conditions expected for an ‘exact date’ a few weeks away.”

Where do the weather headlines come from?

The UK is one of the most challenging regions to provide robust longer-range information, as it is dominated by the atmospheric circulation over the North Atlantic, which is highly variable. While there tends to be a good deal of agreement between forecast models at a short range, differences increase at a longer range, highlighting the uncertainty in weather conditions further ahead.

An individual weather chart from a specific model run will not provide a genuine balanced forecast, it’s the job of meteorological experts to capture the nuance between what different charts and models are suggesting, and then to create a forecast that demonstrates the most likely outcome as well as any uncertainties and intricacies.

However, forecast models from a range of professional organisations are available in the public domain for free and sometimes a singular model run, often for weather weeks away, gets used by some online outlets to suggest the ‘exact date’ certain conditions will occur. One-off, individual weather charts cannot represent a definitive forecast with anywhere near the certainty that some apply to them.

The Met Office uses ensemble forecasts to quantify uncertainties in weather prediction and estimate risks of particular events occurring. This means that rather than relying on one single model run, which takes a picture of the current atmosphere and attempts to model it into the future, the simulation is run hundreds of times from slightly different starting conditions.

Snow imagery often accompanies some excitable headlines.

This means that expert meteorologists can look at the spread of scenarios ahead of issuing a forecast. If all the model runs are quite similar, then confidence is higher, but if they're varied, then there's lower confidence.

Alex explained: "While forecast accuracy is improving, there's always an element of uncertainty when forecasts talk at longer ranges. What isn't always captured in the headlines is this uncertainty, and why that exists in the forecast.

"In Met Office forecasts, we try to explain the levels of uncertainty and reasons for it in our in-depth output. This is particularly useful for those who like to look at a forecast at a slightly longer range."

For those that want to go in-depth into the weather forecast and the drivers of UK weather, the Met Office's YouTube series Deep Dive and 10 Day Trend provides insight and explanation on the weather patterns of the UK.

Getting an accurate forecast

While the majority of reporting on the weather is fair and accurate, there're a few things you can do to make sure you're getting the accurate information you need.

Some tips from us include:

- Check the source
- Check the weather charts
- Check for uncertainties
- Check the Met Office

Find out more about weather forecasting in the news media and how to get the information you need.

Date Created

November 2023

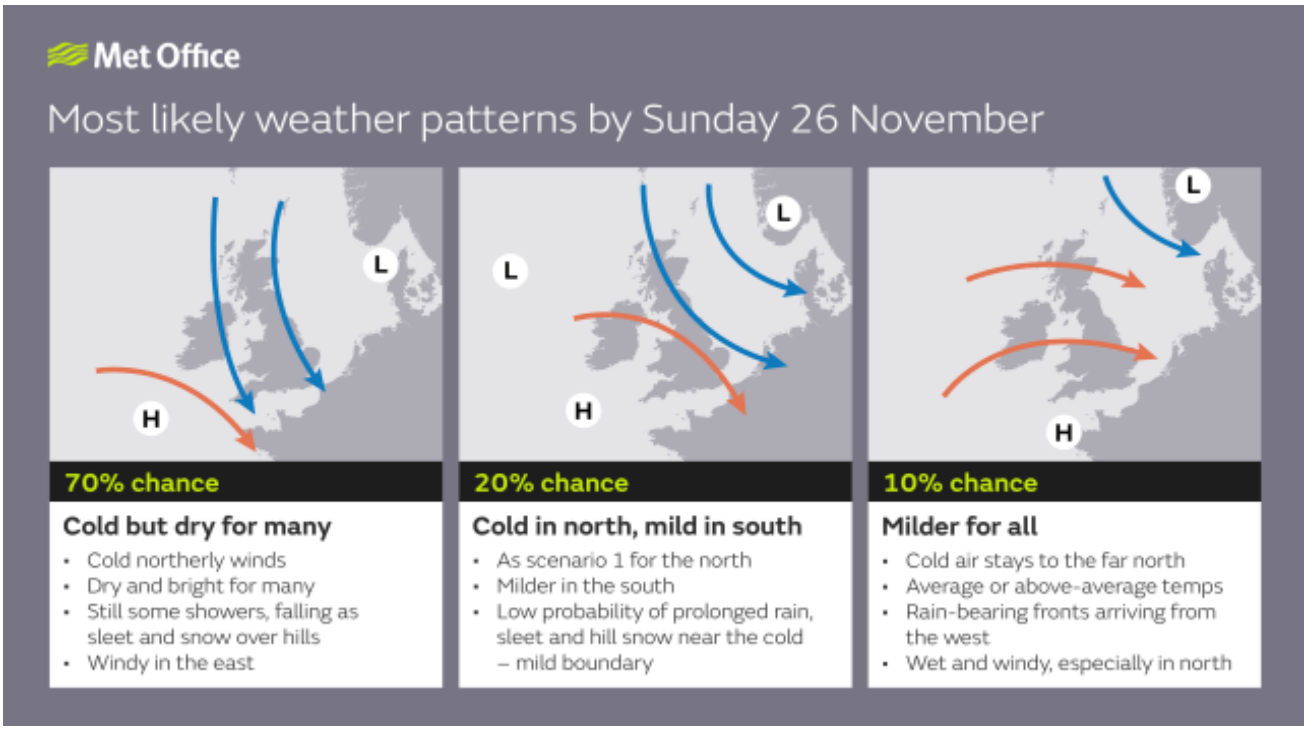
Snow or no snow.. what do we know?

Description

There is a lot of media speculation in the air, but it almost certainly won't be accompanied by disruptive snow. That is the view of Helen Caughey – a Met Office Deputy Chief Forecaster.

She said: "Already there is a lot of media speculation about the prospects for snow later this week and for a white Christmas. Whilst it is too early to give any indications for Christmas, some colder weather is likely for the end of the week, and into the weekend.

"So, what do we know. There is a reasonably strong signal for lower temperatures across the UK by the weekend. But that isn't guaranteed, and those lower temperatures don't mean widespread snow. There is a 70 per cent chance that areas as far south as southern England could experience overnight frosts and a general reduction in temperature. However, there is still a 30 per cent chance that the colder conditions won't get that far south. Any falling snow is likely to be confined to the far northeast, and hills and mountains of Scotland."


Met Office
Most likely weather patterns by Sunday 26 November
L
H
70% chance
Cold but dry for many
Cold northerly winds
Dry and bright for many
Still some showers, falling as sleet and snow over hills
Windy in the east
L
H
20% chance
Cold in north, mild in south
As scenario 1 for the north
Milder in the south
Low probability of prolonged rain, sleet and hill snow near the cold – mild boundary
L
H
10% chance
Milder for all
Cold air stays to the far north
Average or above-average temps
Rain-bearing fronts arriving from the west
Wet and windy, especially in north
Potential change in weather regime from Friday 24 November 2023

Aidan McGivern is a Met Office senior weather presenter. Commenting on the outlook for the festive period he said: “Christmas is still over one month away, so it is impossible with this lead time to have any confidence in a detailed forecast for the big day. The only guides this far out that are helpful in determining a forecast are studying the global drivers of weather and what is happening with the shiftin climatology – how the climate is shifting in response to climate change.

“If you’re seeing stories this far from Christmas promising a white Christmas, you can’t trust them to be right. Of course, there is always a chance, but no-one can have the certainty to be sure this far ahead.”

For further information is available on white Christmas and ten facts about snow

Date Created
November 2023

Making sense of climate change projections

Description

Carbon budgets? Emissions scenarios? Degrees of warming? What does it all mean?

If you are following the climate change conversation, you will have encountered information on future changes in climate. Carbon budgets, high- and low-emission scenarios, and future warming are all frequently discussed.

This can get very confusing, particularly as two or even three of these approaches might be referred to in the same article. There is also significant overlap between these ways of discussing climate change, which can add to the confusion. In this post, we provide an explanation of the differences between these tools and how they are used.

Emissions scenarios

Emissions scenarios are the primary tool climate scientists use to drive climate models and investigate future changes in climate. The scenarios are a series of ‘what-if’ storylines to illustrate the consequences of any mitigation actions that are (or aren’t) taken.

A standard group of scenarios is created to represent a range of different futures, from those which see a lot of climate mitigation (resulting in lower carbon emissions) through to those which see minimal mitigation (higher carbon emissions). These scenarios are then used by climate modelling centres around the world, and the resulting climate simulations underpin much of the Intergovernmental Panel on Climate Change (IPCC) Physical Climate Change report. The scenarios enable decision making around adapting to (and avoiding) the worst effects of climate change.

The most recent set of scenarios are called the Shared-Socioeconomic Pathways (SSPs); whilst a previous version was called the Representative Concentration Pathways (RCPs). The SSPs combined the potential emissions changes with a range of socio-economic factors to develop their five different storylines. SSP 1-1.9 represents a low-emissions scenario, whilst SSP 5-8.5 represents the highest level of emissions and minimal mitigation. Irrespective of the emission scenarios used, the output provides day-by-day projections for the future.

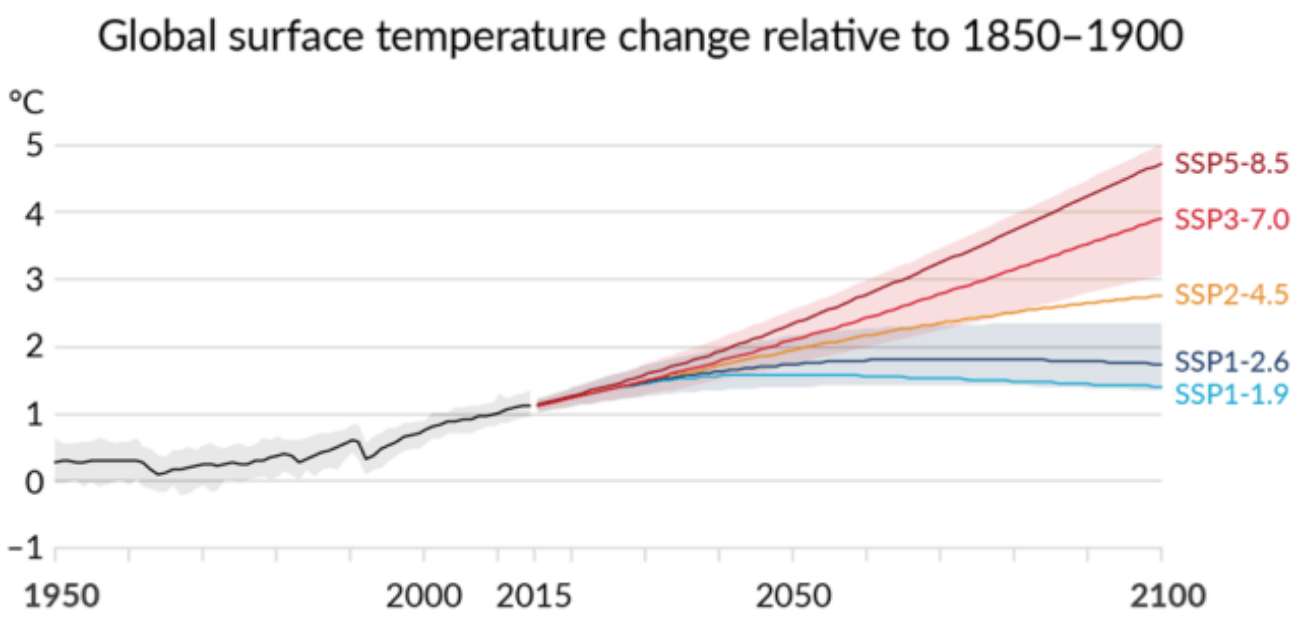


Figure 1. Global surface temperature change 1950-2100 as a difference to the 1850-1900 period. This figure is a reproduction of Figure SPM.8 from the IPCC 6th Assessment Report WGI Summary for Policy Makers.

Figure 1 shows the mean future warming from five of the SSPs, with shading which demonstrates the range of uncertainty for the SSP1-2.6 and SSP3-7.0 scenarios. All five simulations use the same historical period through to 2015 and then project forward from then. The figure allows you to see how the scenarios diverge as the different levels of emissions they represent affect future warming.

Global warming levels

In 2015, COP21 resulted in the Paris Agreement, which committed to restrict warming ‘well below 2 °C’ (compared to the 1850-1900 baseline) and that countries would pursue efforts to limit the increase to 1.5 °C above pre-industrial levels. Since then, there has been an increased use of global warming levels (GWLs) in the communication of climate change.

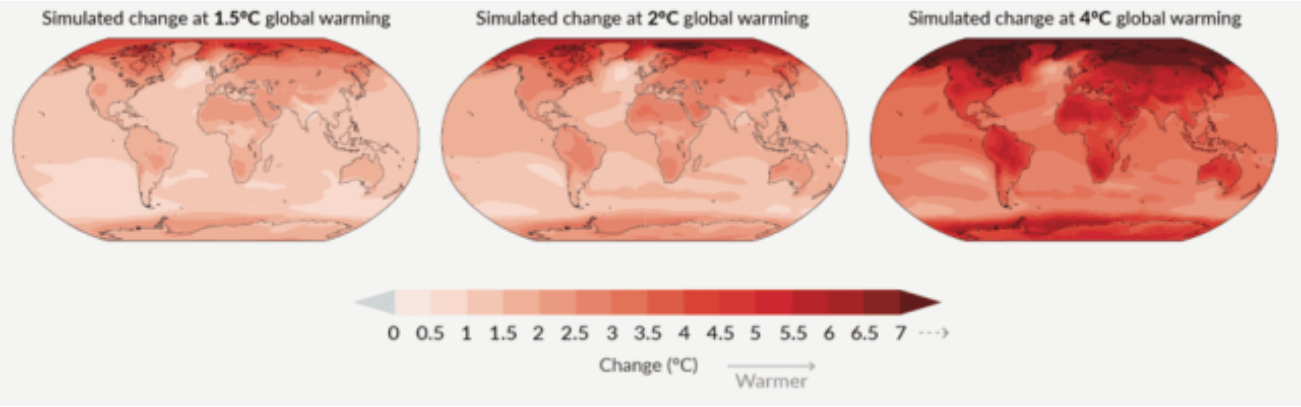

Simulated change at 1.5°C global warming
Simulated change at 2°C global warming
Simulated change at 4°C global warming
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7
Change (°C)
Warmer

Figure 2. Global mean surface temperature change for warming of 1.5 °C, 2 °C and 4 °C above the 1850-1900 baseline period. Figure modified from Figure SPM.5A from the IPCC

6th Assessment Report WGI Summary for Policy Makers.

The GWLs come without a timeframe and represent a world that has reached the stated average warming for the period. It allows the user to investigate a world that has reached a certain level of global mean temperature regardless of the time at which that level has been reached, albeit acknowledging that many impacts – such as sea level rise – will not stabilise at a given temperature. GWLs have been used in a range of circumstances, including the UK's Climate Change Risk Assessment where they underpinned the assessment of future climate risk.

They are also used to investigate extreme events and impacts related to human health. Figure 2 here compares the differences in surface temperature at 1.5 °C, 2°C and 4°C, to highlight differences in warming response between those three different GWLs.

Carbon budgets

A carbon budget (as defined in the IPCC AR6 Glossary) looks at 'the maximum amount of cumulative net global anthropogenic carbon dioxide (CO?) emissions that would result in limiting global warming to a given level'. Whether considering observed changes in recent climate or looking at future changes using global warming levels or emissions scenarios, there is a carbon budget associated with them.

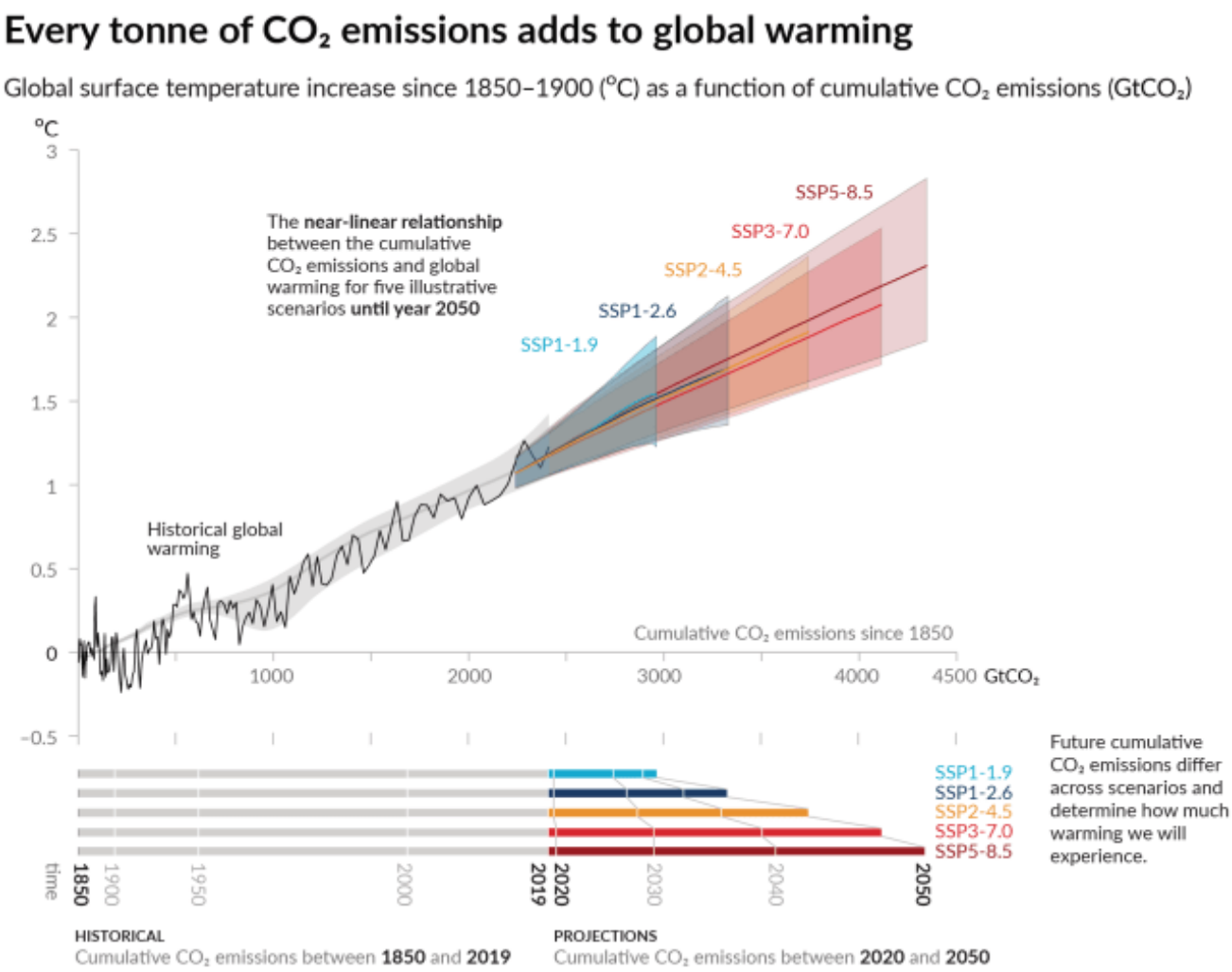


Figure 3. Cumulative emissions between 1850-2019 (grey) and the remaining carbon budget for five of the SSP scenarios (colour) out to 2050. Figure modified from Figure SPM.10 from the IPCC 6th Assessment Report WGI Summary for Policy Makers.

Figure 3 represents the carbon emissions that have occurred (the grey bars) and then the future budget that remains for five SSP scenarios used in Figure 1. This provides a ‘budget’ for the total cumulative emissions that could be emitted within the respective scenarios. It is also possible to represent these budgets through time with respect to the amount of carbon being emitted each year until the point emissions reach net zero.

How these link together…

The future carbon emissions detailed in the carbon budgets underpin the creation of the original, different emissions scenarios. The emissions scenarios then drive the climate models from which the global warming levels can be calculated. The level of warming simulated by each emission scenario then enables informed discussion about the mitigation required to reduce potential impacts which feeds back into discussions around carbon budgets. This can then evolve to determine how much of the budget remains to keep within a certain level of warming.

…and how they are used

Carbon budgets are calculated based on our knowledge of the earth system – how the climate responds to the amount of CO? and how natural ecosystems emit and absorb CO? from the air. The budget depends on land use changes and also the make-up of fossil fuel sources of energy (coal vs gas vs oil) and the use of alternative fuel sources. Knowing how much CO? we can emit to stay under certain temperature thresholds helps governments negotiate how this could be achieved. The UK publishes five-year carbon budgets, with the sixth budget covering the period 2033 to 2037 published in December 2020.

Climate model simulations based on emissions scenarios have been at the centre of climate science for over 30 years and are involved in a range of climate impact studies. The scope of this work is very broad, but examples of Met Office work using climate model simulations include creating bespoke storylines for future climate, researching sea level rise and future coastal flood risks, and exploring the impact of future climate on agriculture.

As well as informing research projects, outputs from emissions scenario-based model simulations have also underpinned communications such as the Future Forecast and a collaboration with BBC Sport looking at the 2050s.

Global warming levels allow for the analysis of climate responses at various temperature levels including the risks and potential impacts associated with those specific levels. For example, research into future changes to high impact weather in the UK looked at changes to temperatures and droughts at warming levels from 1.5 °C to 4 °C. By comparing the different metrics at each warming level, it is possible to assess the vulnerability to changes in future a climate regardless of timeframe, and to understand how the warming causes different impacts in the future.

Mitigation and adaptation

These three different ways to measure and predict our future climate are ultimately three different sides of the same (very odd-shaped) coin. All three methods allow us to consider the future and how we respond. It is important to understand the impacts and risks in different emissions scenarios and at different warming levels.

Mitigating against a changing climate by reducing greenhouse gas emissions is critical to limiting warming which would help us avoid the worst impacts of climate change. We also need to adapt to the climate changes we are already seeing and the changes that are expected in the coming decades to make sure we avoid the worst impacts.

Action is required across all levels of society – to find out more about how you can make a difference, take a look at our Get Climate Ready webpages.

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November 2023

Reducing emissions through the Devon Carbon Plan

Description

In this guest blog post from Devon County Council, they explore how Local Authorities can take action to reduce emissions in their area, and how the Devon Carbon Plan is doing this.

An independent report for the Climate Change Committee, ‘Local Authorities and the Sixth Carbon Budget’ (2020), found that Local Authorities (LAs) “have powers or influence over roughly a third of emissions in their local areas.” Here we look at how LAs can reduce emissions through what they directly control, what they can influence, and what actions are most likely to be taken by individuals and communities. The report includes a figure from Coxcoon and Roberts (2020) that illustrates the scope of LAs’ influence on emissions.

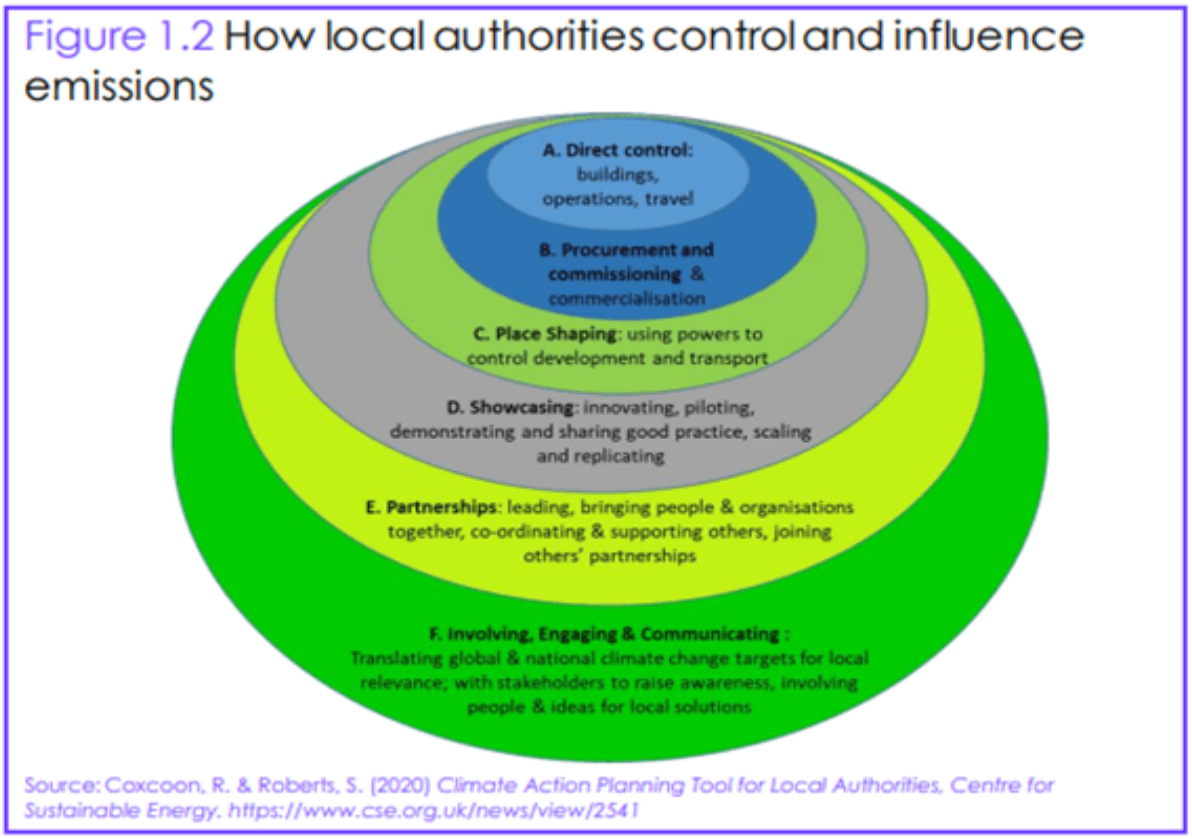
Figure 1.2 How local authorities control and influence emissions
A. Direct control: buildings, operations, travel
B. Procurement and commissioning & commercialisation
C. Place Shaping: using powers to control development and transport
D. Showcasing: innovating, piloting, demonstrating and sharing good practice, scaling and replicating
E. Partnerships: leading, bringing people & organisations together, co-ordinating & supporting others, joining others' partnerships
F. Involving, Engaging & Communicating : Translating global & national climate change targets for local relevance; with stakeholders to raise awareness, involving people & ideas for local solutions
Source: Coxcoon, R. & Roberts, S. (2020) Climate Action Planning Tool for Local Authorities, Centre for Sustainable Energy. https://www.cse.org.uk/news/view/2541

Applications to Devon

Devon County Council (DCC) has a plan to reduce its own emissions, while the Devon Carbon Plan acts as ‘Devon’s roadmap to net-zero by 2050 at the latest’ to tackle emissions countywide. The plan covers a range of sectors and includes actions for individuals, communities, organisations and local

policy makers. It is the result of collaboration between an independent Net-Zero Task Force (NZTF) and 30 Devon Climate Emergency (DCE) partners – of which DCC is the secretariat – including LAs, emergency responders, research institutions, utility operators and more. Between these, DCC can make the most of its direct and indirect influence for emissions reduction.

Below is a brief insight into how LAs can take action to reduce emissions in their area with examples from DCC and the Devon Carbon Plan, segmented with Coxcoon and Roberts' (2020) scale.

Direct control

DCC has been working to reduce direct emissions from its operations since 2012 and, since 2019, has an ambitious target to be net-zero by 2030. DCC produces an annual footprint to monitor progress and has published a Carbon Reduction Plan. It includes actions to retrofit offices, electrify the fleet, and switch to LED street lighting with improved controls.

Procurement

LAs manage billion-pound budgets and employ many local people, so embedding environmental value into procurement processes is a key tool in emissions reduction. DCC is working on a Low Carbon Procurement Strategy, which aligns with the Devon Carbon Plan's goal for procurement by Anchor Institutions[1] to contribute to Net-Zero. Additionally, DCC won £3.7 million earlier this year to decarbonise the construction and maintenance of the A382 link road development as part of the Live Labs 2 programme. The pilot scheme will test different low carbon materials and processes.

Place shaping

Local Plans are a significant way LAs engage in place shaping. Devon County Council is collaborating with the Devon and Cornwall Planning Officers Group to monitor and progress actions in the Devon Carbon Plan which guide LAs to demonstrate how their local plans will contribute to radical reductions in emissions as a primary planning objective.

Another opportunity for place shaping is the creation of a Devon Energy Planning Group earlier this year – currently chaired by DCC with representatives from LAs and other organisations with key roles in Devon's energy landscape.

Showcasing

Sharing good practice, replicating effective projects and demonstrating innovation can inspire further action and encourage knowledge exchange. DCC's Green Innovation Fund has supported projects that are forecast to save around 100,000 tonnes of carbon over the next ten years. For example, Devon-based Altilium Metals are now the only company in the UK recovering critical battery minerals from waste EV batteries.

The Net Zero Visions project invites communities to imagine what their areas could look like as net-zero in 2050 in collaboration with DCE, the University of Plymouth and local commissioned artists. It

has resulted in the creation of murals, illustrations, poetry, an animation and a game, all to inspire Devon to think big about a net-zero future, helping DCC to spur action beyond the organisation.

The Net Zero Visions mural on the Sustainability Hub, University of Plymouth

Partnerships

DCC is an active part of several partnerships across the county. As mentioned, DCC provides the secretariat to the DCE partnership which includes Torbay and Plymouth, as well as working closely with the Torbay Climate Partnership and the Plymouth Net Zero Partnership. DCC is also part of the Devon Food Partnership, the Naturally Healthy initiative, and the Devon, Cornwall and Isles of Scilly

Climate Impacts Group (focusing on climate adaptation as a companion to mitigation measures). Through these, DCC can support a wider range of initiatives for emissions reduction and encourage a cohesive approach to tackling emissions between key organisations in the county.

Involving, engaging and communicating

The DCE partnership offers an opening to bring in knowledge and experience from further afield, including two universities and the Met Office. For example, the partnership's NZTF was chaired by an author of the Intergovernmental Panel on Climate Change (IPCC) reports based at the University of Exeter.

The Devon Carbon Plan was created through a series of public engagement events, most notably a demographically representative Citizen's Assembly. DCE uses social media, an email newsletter, and a blog of 'Taking Action' posts to encourage public involvement in reducing emissions. DCE also participates in events such as the Devon County Show.

There is much still to do in Devon as we work towards net-zero and DCC remains engaged in networks of LAs so that we can continue to learn from others and to share our experience.

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Differing Net Zero definitions must ‘mesh’ say Met Office scientists

Description

A new paper published in Nature has highlighted a fundamental mismatch in the way greenhouse gas emissions are measured which could mean that Net Zero could be met in one definition up to five years ahead of the other.

Golden wheat harvested at sunset with combine harvester generated by artificial intelligence

The IPCC report shows that global temperature will stop increasing when we reach ‘net zero’ emissions of CO_2. To achieve this, human activity cannot put more CO_2 into the atmosphere than it removes – we need to massively reduce our emissions, with some removal of CO_2 to help areas which are really hard to decarbonise. This sits behind the principle of Net Zero, which countries including the UK hope will be reached by 2050.

The paper by Gidden et al, highlights the differences between the two key greenhouse gas accounting systems: one which underlies the IPCC statement that net zero will halt global warming; and the other from how nations produce a National Greenhouse Gas Inventory (NGHGI) to report to the UNFCCC (United Nations Framework Convention on Climate Change).

Professor Chris Jones, who is the Met Office’s lead on carbon budgets, was asked to write a discussion document alongside the paper.

Jeopardy

Chris Jones said: “Both of the key systems for measuring greenhouse gas emissions work well on their own. But there is a challenge when they have to work together in one view. It’s a little like having a bank account and spending in one currency, while trying to save in another. Both currencies work fine on their own, but merging the two together requires an exchange rate mechanism otherwise you risk financial jeopardy by spending beyond your means.”

The mismatch surrounds the different treatments of flows of carbon on so-called managed lands, such as croplands or plantations; these flows can be reported either as natural or human-induced depending on the definition being used. Under the IPCC definition, carbon cycle processes happening on managed lands (such as plantations) are considered natural (and therefore don’t contribute towards progress to net-zero), whereas under the UNFCCC definition the same processes are considered human-caused.

Chris added: “Although these differences may sound negligible, the result is that the mismatch could add as much to five years to the difference between Net Zero being declared in one system and confirmed by the other. This matters hugely because Net Zero could be being celebrated for several years while billions of tonnes of emissions are still being released to the atmosphere which would cause further warming. The two processes must mesh – or we will miss our climate targets.”

The comment piece and original paper appear in the journal Nature.

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November 2023